

## WOOD PASTURES IN CENTRAL SLOVAKIA – COLLAPSE OF A TRADITIONAL LAND USE FORM

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### ABSTRACT

Wood pastures with pollard trees have been a common land-use type across Europe. The trees, besides having positive environmental effects on livestock, served as important source of fodder and wood. Pollarded wood pastures were hence a multifunctional, state of the art, highly productive farming ecosystems. Despite relatively drastic treatment, the trees regenerated quite well, and grew to relatively high-age. When pollarding lapses for longer period the wood pasture may confusingly resemble an ancient forest. Using aerial photographs of Slovakia from 1949–1950 we have identified 950 individual wood pasture localities with total area of 265.5 km<sup>2</sup> within the Self-Governing Region of Banská Bystrica. Majority of identified wood pasture habitats were actively managed in the first half of the 20th century. Nowadays, less than 2.5% has preserved its original structure, the rest has been abandoned (92.8%) or actively transformed into different land-use form. We conducted a field survey in order to identify historical pollarding within the Gavurky protected area, one of the last and best preserved wood pastures in Slovakia. By evaluating habitual features, we were able to confirm historical pollarding for more than 80% of present veteran trees. We provide framework for identification of pollarding in historical wood pasture localities, applicable in the conditions of long-term management cessation.

**Keywords:** silvo-pastoral systems, pollarding, pannage, traditional land-use, land use change

### INTRODUCTION

Wood pastures represent a specific land-use form which has persisted in the European region as a specific part of rural landscape. Exact classification of these habitats is quite problematic, as they represent diversified group of ecosystems with mixed properties and multi-functional use (Hartel et al., 2015), integrating livestock grazing (cattle, sheep, goats, horses, pigs, even buffalo) with trees and their associated goods and services (Mos-

quera-Losada et al., 2009). The trees play important roles in modifying micro-climate and soil protection, and may also benefit grassland (Manning et al., 2006). Additionally, trees are cut for fodder to feed livestock, or for wood (Sádlo et al., 2005; Jørgensen–Quelch, 2014). The composition of tree layer is geographically diversified, in general oak is a prevailing tree species, peer and willows are frequent as well (Opperman, 2014).

Even nowadays they represent a wide spread habitat of the cultural landscape of Europe (Bergmeier et

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al., 2010). In Spain and Portugal wood-pasture cover approximately 3.1 mil ha (Costa et al., 2014), but these systems are well represented in number of European countries as well, including Sweden, Germany, Hungary, Romania, Austria and Switzerland (Herzog, 1998; Hartel et al., 2015), on the other hand, there are virtually no wood-pastures for instance in the Czech Republic (Hartel et al., 2015).

Nevertheless, even in countries with extant areas of wood pastures, traditional management has lapsed within last decades and new forms of management have usually lead to degradation of these habitats (Hartel et al., 2015). In our region the issue of wood pastures has been covered very poorly, even in two recent monographs dedicated to the traditional land-use forms in Slovakia (Hreško-Petluš, 2015; Špulerová et al., 2017), this land-use type is barely mentioned. We however stress, that the situation in Slovakia is very similar to the Czech Republic, where wood pastures are considered entirely absent due to extant encroachments related to complete absence of active management (Hartel et al., 2015). After 1950 rapid cessation of management or land-use change took place across almost all of the wood pastures in Slovakia. Recently, except of few protected localities, all habitats are strongly degraded or vanished, and almost forgotten. Nevertheless, from the historical perspective this is relatively recent trend (Morzyniec et al., 2016), and a consequence of only several decades of management lapses.

## METHODOLOGY OF WOOD PASTURE IDENTIFICATION

In order to analyze the historical distribution of wood pastures in Slovakia, we used the aerial photographs of Slovakia taken during the first complex aerial mapping of Slovak territory in 1949–1950. These photographs provide a unique opportunity for a historical insight into the traditional land-use, as they capture the Slovak landscape in the period before large scale reorganization during the process of collectivization and transformation to centralized intensive landscape management.

We thoroughly examined the area of the Self-Governing Region of Banská Bystrica (9 454 km<sup>2</sup>) for wood pasture habitats. These were visually identified based on characteristic textural features, which we rec-

ognized as indicative based on the inspection of several preserved wood pasture localities (Gavurky, Cibajka). These features included mainly open tree formation with dominant solitary trees, evident erosion tracks related to grazing activities, well identified boundaries of the land-use form and no obvious transition zones to a closed canopy forest (See: Fig. 2 and 3).

We would like to stress that in 1950 majority of identified wood pasture habitats had no signs of management cessation, and were probably intensively used and even newly established.

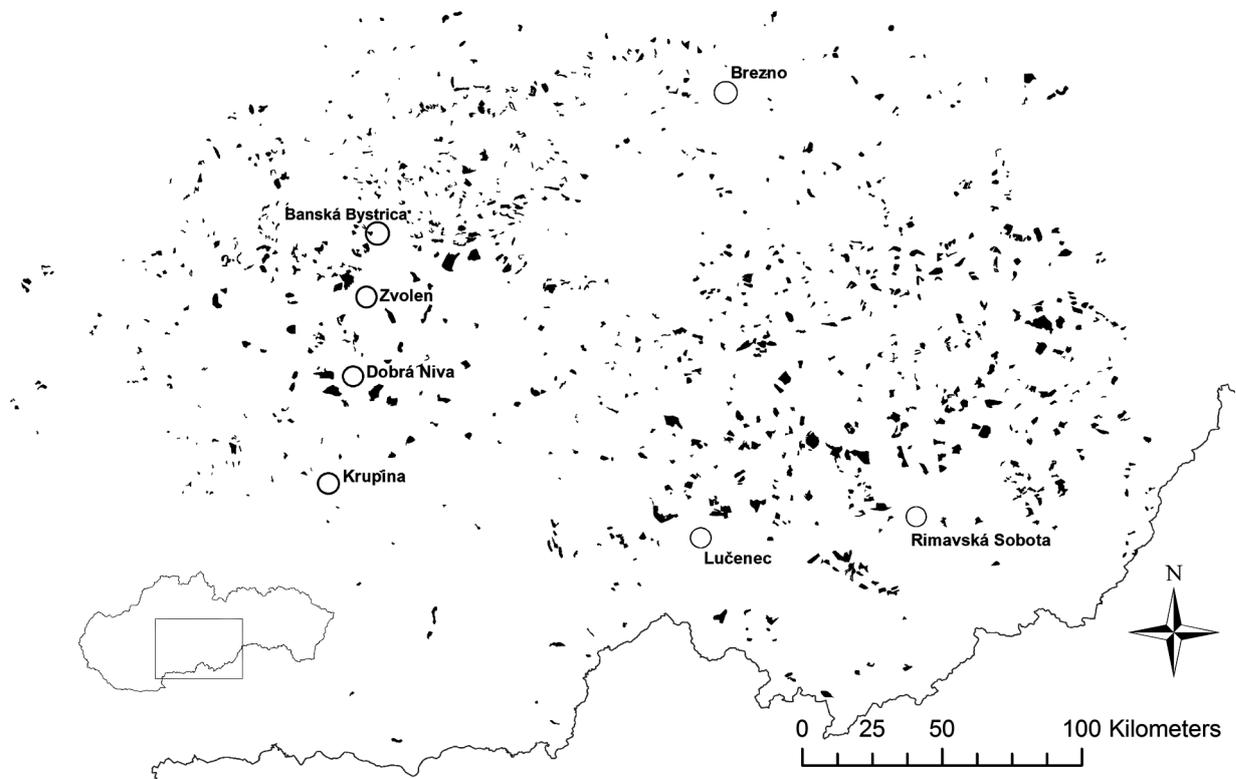
In order to identify the impact of management cessation we compared the historical condition of wood pastures with recent orthophotomaps (from 2010). This approach allowed for the specification of actual habitat degradation. We created a complex geodatabase with information about spatial distribution, historical area and present state of wood pasture habitats.

The following cartographic materials have been used as an input: aerial photos from 1949–1950 (black and white, resolution 0.5 m, © GEODIS Slovakia, Military Topographic Institute Banská Bystrica) and satellite images from 2010 (© EUROSENSE, GEODIS Slovakia). These materials have been used via WMS server for further processing in the ArcMap 10.3 program which was used for all procedures applied in this study.

## RESULTS AND DISCUSSION

### Distribution of wood pastures in Slovakia

Based on historical aerial photographs of Slovakia from 1949–1950 we have detected surprisingly high proportion of actively managed wood pastures across the whole region. Only within the Self-Governing Region of Banská Bystrica we identified more than 950 individual wood pasture localities with total area of 265.5 km<sup>2</sup>, hence covering 2.8% of the district area (see: Fig. 1). This set of localities was formed by a diverse group of wood pasture habitats, with differences in area, proportion and age of trees, however bearing common characteristic features, like frequent erosion tracks from grazing animals and distinct spatial delimitation (with well-defined boundaries), suggesting that wood pastures didn't represent a transitional habitat between open field and forest, but rather a distinct and well established land-use form (see: Fig. 2).



**Fig.1.** Distribution of wood pastures (shown in black) in the area of the Self-Governing Region of Banská Bystrica based on the visual analyses of aerial photographs from 1949–1950



**Fig. 2.** Aerial photograph from 1950 of the vicinity of Dobrá Niva (Central Slovakia) with well preserved and actively managed wood pasture locality Gavurky. Note abundant erosion tracks indicating intensive grazing activity in the area. (Historical orthophotomap © GEODIS SLOVAKIA, s.r.o.; Historical AMS © Military Topographic Institute Banská Bystrica)

These habitats were distinguished in the form of an intact and actively managed areas with conspicuous texture situated in the vicinity of the settlements. They tended to be localized within a spatial and functional gradient of land-use, organized in the sense of “village-field-wood pasture-closed forest”, a typical landscape organization in central Europe (Sádlo et al., 2005). Well-regulated structure with no hints of shrub encroachments was also typical for this period, suggesting that the wood pastures had been an integral and actively managed land-use form of the Slovak rural country until the first half of the 20th century. Moreover not only old well preserved wood pastures were recognized from this period, but also many examples of newly established wood pastures with considerably younger trees (see: Fig. 3). Unfortunately, regardless of the age of the trees, almost all wood pasture localities have been abandoned or irreversibly altered in the second half of the 20th century (see: Table 1).

During the politically driven process of transition to large-scale production scheme after 1958, the Slovak landscape underwent through a well-covered process of unification, which resulted in the large-scale

landscape of open fields with consequent ecological problems (Lipský, 2000). Traditional land organization persisted mainly on steep terrain, less fertile soils, and in the vicinity of isolated settlements (Lieskovský et al. 2014); current area of traditional agricultural landscapes in Slovakia is less than 1% (Špulerová et al., 2011). Unlike arable land, generally transferred towards more intensive forms paralleling the general trends in central and eastern Europe (Śmigielski et al., 2017), the wood pastures were rather put aside of any form of management, succumbed to a gradual overgrowing after the traditional grazing lapsed for several decades. As a consequence, more than 90% of wood pastures present in the territory of the Self-Governing Region of Banská Bystrica in 1950 are recently fully overgrown (see: Fig. 4); the rest has been transformed to different land-use forms, including meadows, arable fields or even stone quarries or partly overgrown. Only 2.3% of former wood pasture localities preserved their original open structure. Hence, in approximately sixty years Slovakia has entirely lost its characteristic landscape feature, which for centuries had been an important part of our cultural landscape.



**Fig. 3.** Aerial photograph from 1950 of a wood pasture locality in the vicinity of Dobrá Niva (Central Slovakia). Note the differences in scale and density of trees between upper and lower wood pastures and well defined borders of this land-use form. (Historical orthophotomap © GEODIS SLOVAKIA, s.r.o.; Historical AMS © Military Topographic Institute Banská Bystrica)

**Table 1.** Land-use transformation of wood-pastures in the period of 1950–2010 in the Self-Governing Region of Banská Bystrica, Central Slovakia.

Recent land-use	Area (km <sup>2</sup> )	%
Arable land	1.91	0.71
Grassland	11.13	4.19
Forest/Encroachment	246.36	92.82
Wood pasture	6.05	2.28
Σ	265.45	100.00

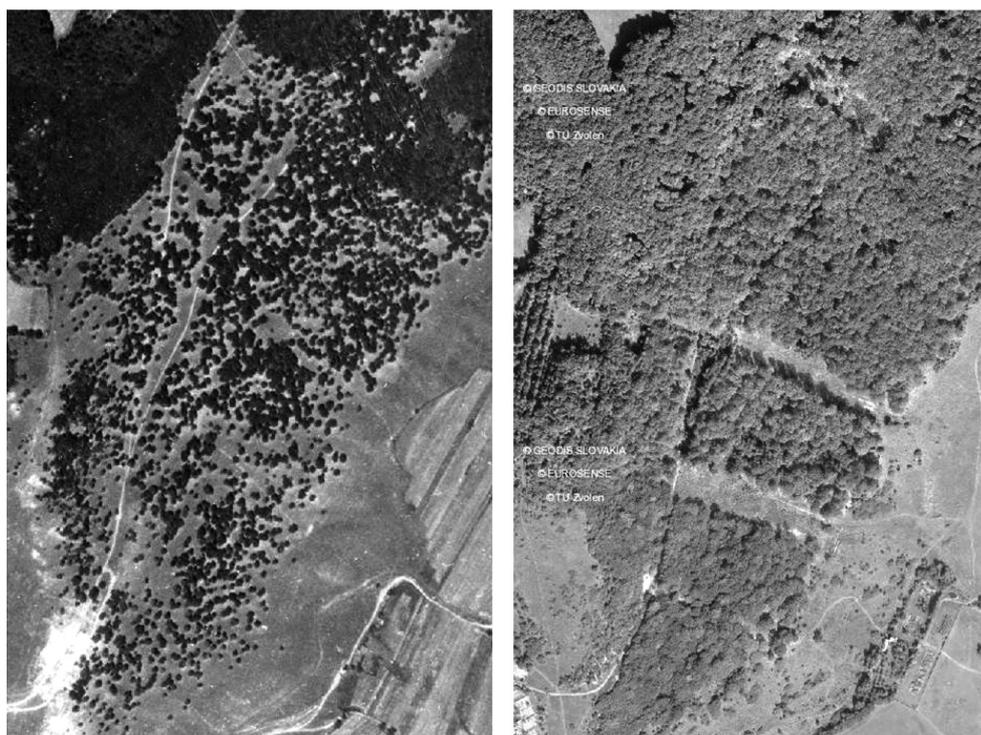
### Recognizing relics of pollarded wood pasture in the field

Historical evidence demonstrates that wood pastures were an important and widespread land-use form throughout Europe. However during the modern period a complex process of land-use change has started,

which resulted in nowadays conversion of previous wood pastures in to the suite of land-uses, like arable land, permanent pasture and meadow, and prevalently a closed woodland (Jørgensen–Quelch, 2014).

Relic wood-pasture sites may be identified using old records or maps or a combination of traits such as the presence of old (veteran) trees, trees with symptoms of former grazing pressure and/or leaf-hay collection, open or partially open grown trees, uneven stocking, irregular site boundaries, patchiness with frequent glades and areas with scattered trees (Bergmeier et al., 2010). Even in normally structured dense woodland, the presence of open grown veteran trees is invariably a sign of a former wood pasture or an open woodland (Jørgensen–Quelch, 2014).

We focused on the identification of habitual traits of trees related to the practice of historical pollarding within a well-defined and preserved wood pasture. Since the pollarding is related to the management



**Fig. 4.** Wood pasture at the Piteľová showing an intact actively managed wood pasture in 1950 (left) and its current conversion to a closed canopy forest (right) as a consequence of the absence of grazing. (Historical orthophotomap © GEODIS SLOVAKIA, s.r.o.; Historical AMS © Military Topographic Institute Banská Bystrica; orthophotomap © EUROSENSE, s.r.o. and GEODIS SLOVAKIA, s.r.o.)

originated from the Medieval period, we consider it an indicative of a long-term continuity of wood pasture at the particular site.

Within the area of Gavurky wood pasture (see: Fig. 5) we analyzed a set of veteran oak trees which includes several hundreds of solitary trees of pedunculate oak (*Quercus robur* L.). Recently the area is partly encroached as a consequence of lapsing traditional management; nevertheless it represents one of the best preserved wood pasture habitats in Slovakia protected as a part of the NATURA 2000 Network.

Majority of veteran oak trees have distinct solitary shape, most of the trees exceed the age of 250 years, with estimated maximums of 400+ years. Although the trees in this area resemble those from several other wood pasture localities we have visited so far (e.g. huge open grown veteran trees with distinct solitary shape), they carry specific habitual features unique to this site, related to the past working conducted on the trees.

Most of the veteran trees have the form of a fan - a short central trunk with several radiating branches growing from the crown. The trunk usually supports two up to five branches, all relatively equally thick in diameter. Frequently the 2.5–4 m tall trunk has one up to several bark ridges, forming a circular scar. The

sections of trunk separated by such ridges have distinctly different bark structure, lower sections being considerably more mottled and coarsely textured (see: Fig. 6), suggesting distinctly different age of individual trunk sections. The existence of such sections demonstrates repeated removal of the crown or even parts of the trunk during historical workings. Recurring lopping is frequent in the crown section. Despite relatively drastic treatment, the lapsed trees have regenerated well, and nowadays the site resembles an ancient open woodland. Based on the level of regeneration we estimated that last pollarding event took place approximately 80–100 years ago, which may also be an interval between individual pollardings (repeated up to three times on the oldest trees). Based on these estimates we assume that the site has been under continuous management, originated from the medieval practice of pollarded wood pastures, for a period of 500 years.

Around 80% of veteran trees at the site carry pollarding related features, suggesting that pollarding was once a dominant practice across the whole site. This proportion is unprecedented in other wood pastures we have visited so far (usually there are no pollarding relics present), suggesting that Gavurky represent one of the oldest wood pasture sites in Slovakia.



**Fig. 5.** Aerial photograph of the Gavurky wood pasture which represents one of the oldest and best preserved wood pasture habitats in Slovakia. (Photo by Michal Wieżik)



**Fig.6.** Historically pollarded pedunculate oak from the Gavurky wood pasture. Note the different habitual malformations related to the pollarding practice, including stem and branch bark ridges, with well-defined sections of different bark roughness. Characteristic fan like habitus is typical for majority of veteran trees in the area. (Photo by Michal Wiezik)

### Wood pollarding and grazing activities as a part of multifunctional land-use

Despite nowadays strict determination of wood pasture as a non-forest habitat with open grassland understorey vegetation (see Bergmeier et al., 2010), the situation is quite different in historical context and especially so with regard to the Medieval understanding of a forest in general.

The medieval ‘forest’ did not imply continuous tree-cover, although many examples of ‘forests’ were well wooded. Designated ‘forests’ included wooded lands and open formations alike, hence usually they were operated as multi-purpose areas, balancing wood collection, hunting and pasturage (Wilson, 2004). ‘Forest’ most often designated a legal entity consisting of extensive land, including both woodland and pasture, within which the right of hunting was reserved for the king or his designees and was subject to a special code of laws administered by local officials (Watkins, 1998).

Trees could not be freely used; there were regulations about the use of trees. This applied in particular for trees which produced mast for pigs, so called fruit-

ful trees (*arbores fructiferae* or *silva fructicans*) (Vera, 2000) and oak trees in particular (*arbores glandiferas*) (Hudáček, 2014).

For instance, Anglo-Normans practiced wood conservation in many ways, collecting wood for daily use without clear-cutting. Wood collection relied on the practices of coppicing and pollarding. Trees could be cut approximately one meter above ground level to create a sprouting stump (coppicing) or higher on the trunk so that young sprouts were out of the reach of grazing animals (pollarding) (Wilson, 2004). These practices helped also to increase the production of acorns (Hudáček, 2014).

Pollarding goes back far beyond the earliest written allusion, as shown by remnants of pollarded trees from the Neolithic site of the Somerset Levels of c. 2800 BC (Rackham, 1980). The main era of pollarding however dates to the Middle Ages when it became a critical part of medieval landscape management and wood (forest) conservation.

The practice of pollarding makes use of natural tendency of trees (especially oaks and poplars) to re-

generate branches, crown or even sections of trunk after these are shed or cut (Rackham, 1991). The practice of pollarding has occurred commonly in Europe since medieval times, and has been widely used especially in the wood pastures (Jørgensen–Quelch, 2014). Pollarding was done higher on the trunk (Wilson, 2004), leaving large portion of the stem undisturbed by the practice. In this way, the pollarded trees (or their lower section) could reach relatively high age, moreover the practice of pollarding increased the lifespan of a tree. Trees normally age because they reach a maximum height and branch size, thus fixing the amount of leaves available to gather nutrients, but continue to grow in diameter. Eventually the tree cannot supply itself with enough water and nutrients to maintain the thick trunk, so the branches begin to die. Pollarded trees, on the other hand, are capable of living much longer because each time they are cut, the ageing process (at least partly) restarts (Rackham, 1991).

In oak, after pollarding, existing dormant buds are activated and bore their way out through the bark within several months. Alternatively, any existing small branch remaining on the tree is capable of an upright growth and may become a leading shoot (Rackham, 1991). This new wood, and the associated foliage, could be used for fuel, small scale timber and fodder. The tree is capable of regeneration to its former habitus, and especially so, if the management lapses for several decades. Lapsed tree may confusingly resemble an ancient (uncut) tree, similarly, abandoned wood pasture may resemble an ancient (unmanaged) forest (Leuschner–Ellenberg, 2017); however the scars and habitual features originated from the technique remain and can be identified.

The importance of *arbores fructiferae* was related to the high incomes from pannage. For example, in 1590 about 100 time higher financial income originated from the pig pannage (8 659 Maria guilders) compared to wood harvest (84 Maria guilders) in the area of Lauensteiner Amtforst. Similar ratios are listed from many other regions (Mantel, 1990). Thus, the use of the forest was highly prioritized towards pasture (pannage) practice. The long-term and massive pannage practice could potentially result in harming of the forest productivity and decrease significantly the productive capacity of the soil. The council of the

German City of Dortmund complained in 1635 that the oak forest which had once fed up to 3000 pigs was only able to provide pannage for at most 200 in that year (Hesmer, 1958).

Initially, the grazing of livestock was free. A commoner could graze as many animals on the common or in the *forestis* as was needed to meet the household needs for food (Tack et al., 1993). However, the food productions had to be in concordance with the environment bearing capacity, a common had to remain a closed regulated system. Nothing could be traded from the common, neither anything could be brought in. The sold products which originated from the common would be seen as disadvantaging of other members of the community, which was against the rule of equality with regard to meeting the people's need. The number of animals kept was therefore limited, reflecting the capacity of the common or *forestis* to provide enough fodder all year round (Vera, 2000).

Regulations on grazing date back to the 6th century, however up to the 13th century there were no direct regulations on stock density or intensity of grazing practice. The earliest forms of regulations were concerned with payments for the pannage of pigs (Rackham, 1980), or the limitations on cutting foliage, especially in regard with the fruitful trees, such as oak, which were protected from cutting in many regions of Western and Central Europe until the 15th century (Mantel, 1990).

In the Middle Ages, pork was an essential source of energy for the winter (Tack et al., 1993) and pigs were commonly left to pannage in the forest. The latin expressions used for this practice such as *sagina porcorum*, *pascua porcorum in glandibus* were often clearly derived from the terms related to swine, pasture or oak (Hudáček, 2014). Other livestock, besides providing meat, milk, wool and manure, was critical element in field cultivations and transport. In the cultivated parts, however, there was little room for grazing livestock (usually they could go to fields only after harvest, and similarly so, the meadows were grazed only after hay-making). Therefore, for the large part of the year, the livestock had to graze in the “wilderness” which represented an integral part of the farming system of that time (Buis, 1985).

Regarding the density of pigs left to pannage in the forest, the data vary in different regions. In England

this was often one pig per acre (0.4 ha) (Rackham, 1980), on European mainland it varied from one pig per 0.24 ha to one pig per 1.2 ha (Vera, 2000). The place where pigs were put out to pannage was often referred to as *Acker*, i.e. the place where oaks are grown (used in this manner from the Middle Ages up to the 18th century). In addition, the term *akker* also meant *mast* i.e. the production of acorns. Trees in the *akker* had to be spared from cutting to provide mast for pigs (Schubart, 1966). Vera (2000) even speculates, that English measure acre, could have an original meaning in a measure for area unit with mast for one pig.

Wood pastures and especially those with pollarded trees have been a well-established and highly effective land-use form. Since the Middle Ages the use of wood pasture has changed, and mainly in regard with the pig pannage, which became less important in the modern age. Also the practice of pollarding has been less frequent in the recent time. Nevertheless grazing of livestock has remained a main disturbance regime maintaining the open structure of a wood pasture in many European countries (including Slovakia) until the first half of the 20th century.

## CONCLUSION

Wood pastures were an important and widespread land-use form throughout Europe, including current territory of Slovakia. In the Medieval they were an integral part of the cultural landscape, representing a very effective land-use form of strategic importance. Integrating grazing activities with sustainable wood harvest and various other products and services in one place, wood pastures were state of the art, highly functional man-made ecosystem paralleling nowadays concepts of a permaculture. Although the grazing practices have changed since the Medieval, basic principles of wood pasture have persisted as a unique land-use form integrated into rural landscape of Slovakia until the 20th century. We have identified 950 individual wood pasture localities with total area of 265.5 km<sup>2</sup> within the Self-Governing Region of Banská Bystrica, which had been actively managed during the first half of the 20-th century.

Unfortunately, it took only six decades of deliberate management absence to completely wipe out this traditional land-use both from our landscape and pub-

lic memory, nowadays only 2.5% of their former territory retained its original structure and functions. Last intact remnants of wood pastures serve today as biodiversity hotspots, however the full potential of wood pasture is largely ignored, which is unfortunate not only due to the broad scale of services these habitats have potential to provide, but also in regard to their cultural and historical value.

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## LASY PASTWISKOWE W ŚRODKOWEJ SŁOWACJI – ZMIERZCH TRADYCYJNEJ FORMY UŻYTKOWANIA TERENU

### ABSTRAKT

Lasy pastwiskowe z drzewami w formie ogłowionej to powszechny typ użytkowania gruntów w całej Europie. Drzewa były ważnym źródłem paszy i drewna, miały również pozytywny wpływ na środowisko zwierząt gospodarskich. Pastwiska leśne z drzewami ogłowionymi były więc wielofunkcyjnymi, najnowocześniejszymi, wysoce produktywnymi ekosystemami rolniczymi. Mimo względnie drastycznego traktowania, drzewa dość dobrze się regenerowały i osiągały stosunkowo wysoki wiek. Kiedy na dłuższy okres rezygnuje się z ogławiania drzew, lasy pastwiskowe mogą zacząć łudząco przypominać pradawny las. Korzystając z fotografii lotniczych Słowacji z lat 1949–1950, w Regionie Samorządowym Bańskiej Bystrzycy zidentyfikowaliśmy 950 pojedynczych stanowisk pastwisk leśnych o łącznej powierzchni 265,5 km<sup>2</sup>. Większość zidentyfikowanych siedlisk sylwopastoralnych była aktywnie zarządzana w pierwszej połowie XX wieku. Obecnie mniej niż 2,5% pastwisk zachowało swoją pierwotną strukturę, pozostałe zostały bądź porzucone (92,8%), bądź aktywnie przekształcone w inne formy użytkowania gruntów. Przeprowadziliśmy badania terenowe w celu identyfikacji historycznych lasów pastwiskowych z drzewami ogłowionymi w obszarze chronionym Gavurky, jednym z ostatnich i najlepiej zachowanych pastwisk leśnych na Słowacji. Oceniając cechy siedliskowe, byliśmy w stanie potwierdzić istnienie historycznych pastwisk z drzewami w formie ogłowionej dla ponad 80% starych drzew-weteranów. Stworzyliśmy schemat identyfikacji drzew w formie ogłowionej w historycznych obszarach lasów pastwiskowych, mający zastosowanie w warunkach długotrwałego zaniechania czy też zaprzestania gospodarowania nimi.

**Słowa kluczowe:** systemy sylwopastoralne (lasy pastwiskowe), ogławianie drzew, tradycyjne użytkowanie gruntów, zmiana użytkowania gruntów